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Pixelated Capacitively Coupled LAPPDs as photosensors for Ring Imaging Cherenkov Detectors with a High-Resolution Timing Capability

Large Area Picosecond Photon Detectors (LAPPDs) are micro-channel plate (MCP) based photosensors featuring hundreds of square centimeters of sensitive area in a single package and capable of providing timing resolution on the order of 30-50 ps for single photon detection. One of the recent LAPPD models (Gen II) gives the opportunity of building finely pixelated 2D readout configurations which, in addition to high-resolution timing, also provide sub-mm spatial resolution required for Ring Imaging CHerenkov (RICH) detectors. The Gen II readout plane is external to the sealed sensor and is a simple printed circuit board that can be laid out in a custom application-specific way for sensitive area pixellation. This provides unprecedented flexibility in choosing an appropriate segmentation that can be optimized for any detector need in terms of pad size, orientation, and shape. In this talk we first report on the design principles and several practical implementations of the finely pixelated Gen II LAPPD readout boards. We present spatial resolution on the level of ˜ 500-700 μm for single photon detection for a variety of such readout planes with 3-6 mm square and segmented pads in a laser-based setup in the lab. Secondly, we present the world's first demonstration of the Cherenkov ring imaging capability of these finely pixelated photosensors in a 120 GeV proton beam setup at the Fermilab Test Beam Facility (FTBF) using an aspheric quartz lens as a source of Cherenkov photons. In this case we achieved ˜ 600 μm single photon Cherenkov ring radius resolution with a readout plane segmented into 4 mm square pixels. And finally, we will present the first results of the June 2022 beam test, where we are planning to demonstrate a simultaneous LAPPD ring imaging and time-of-flight (TOF) particle identification performance in a proximity focusing RICH configuration with aerogel radiator and a mixed π/K beam in the momentum range ˜5-8 GeV/c.

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